Hydrologic Model Manager

Short Name	OWLS
Long Name	Object Watershed Link Simulation
Description	
Model Type	Continuous precipitation runoff models, snowmelt runoff models, unsteady-flow flood routing models
Model Objectives	To physically and visually simulate the real time or short-term hydrological processes for small forested watersheds and to provide detailed information about watershed response to environmental changes.
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Model Structure	(1) Type of basins: Mountainous Source Watershed (expandable to rural, agricultural watershed) (2) Size of basins: in theory, no restriction (3) Nature of simulation: physically-based, continuous, 3-D simulation (4) Components of the hydrologic cycle represented: Precipitation (Rainfall and Snowfall), Solar Radiation, Air Temperature, Snow melting, Infiltration, Exfiltration, Evaporation, Interception, Detention storage, Overland flow, Micropore pipe flow, Ground water flow, Stream flow and related routing processes. (5) The underlying hypotheses: i. Cells: No restrictions on the geometry and size of the simulation units (or cells) for the model. But all cell has to be plane. Cells with different geometry are simulated using a Equivalent Rectangle Approximation (ERA) method, which solved a 3-D hydrologic problem using a simple 1-D model. ii. Network of cells: A watershed is represented by a network of cells, which connected hydraulically via their boundary (edges). Water migrates from upper cells to the lower cells through their edges. iii. Network of edges: A automatic flow tracing model was built-in in the OWLS to generate a network of flow paths and basin boundary. These paths and boundary forms a network of edges and they partition the cells where their cross over. The network of flow path edges becomes the stream network which can expand or shrink as the result of the water balance. iv. Precipitation: Linear spatial interpolation to distribute observed precipitation data into different cells in the watershed v. Interception: Related to the physical property of the forest coverage, a mass balance equation is used for accounting the interception and evaporations. vi. Infiltration: Two considerations: <1> For soil surface infiltration, Modified Horton Infiltration Equation is used with consideration of soil moisture contain. <2> For macropore pipe infiltration, a linear equation with soil surface infiltration rate is used. vii. Exfiltration: Continuity equation was used in conjunction with macropore

flow routing and ground water routing equations.
viii. Detention storage: As the simulation results from mass balance equation from flow routing processes
ix. Snowmelting: Modified Degree-day Model.
x. Overland Flow: Nonlinear Kinematic Wave Scheme Finite-Difference Method.
xi. Micropore Flow: Pipe-bundle Model derived from energy and continuity equation.
xii. Ground Water Flow: Darcy's Law with continuity equation with unsaturated conductivity.
xiii. Stream Flow: Tree structured segment and node stream network with flow routing by Manning's equation and continuity equation.

Interception

Groundwater

Snowmelt

Precipitation

Evapo-transpiration

Infiltration

Model Paramters

There are 46 parameters in the OWLS model, including Canopy (1), Surface (6), Soil (11), Macropore (13), Stream (8), and 9 general parameters. 10 of them are most sensitive parameters to the OWLS model (see table below). As a physically based model, the number of parameters can be reduced or replaced by the field measured data.

Parameter Description Data Range
infiltration0Adjust Dimensionless, adjust factor for maximun infiltration rate. For distributed model, different soils have different lab-tested maximun infiltration rates, the "infiltration0Adjust" parameter is a ratio to adjust all the soil maximun infiltration rates simultaneously to approximate the field condition. This parameter has great effect the proportion of water distribution amoung surface, soil and macropore system. 0.1 ~ 10.
infiltrationCAdjust Dimensionless, adjust factor for maximun infiltration rate. This parameter has great effect the proportion of water distribution amoung surface, soil and macropore system. 0.1 ~ 10.
surfaceMacroporeConst Dimensionless, adjust factor for amount of surface water directly drain into the soil macropore system. It is a proportion factor to the amount of soil infiltration. It has great effect to the peak flow and basically control the flow subdivision between surface flow and macropore pipe flow. 1 ~ 5.
soilMacroporeConst Dimensionless, adjust factor for amount of soil water directly drain into the macropore system. It is a proportion factor to the amount of soil water depth, relative soil moisture content. It has great effect to the base flow and basically control the base flow subdivision between soil matrix flow and macropore pipe flow. 0 ~ 10-3
conductivityAdjust Dimensionless, adjust factor for soil conductivity rate. For distributed model, different soils have different lab-tested unsaturated conductivities, the "conductivityAdjust" parameter is a ratio to simultaneously adjust the hydraulic conductivities for all the soils to approximate the field condition. This parameter has great effect on the soil base flow. 1 ~ 1000
frictionCoeff Dimensionless, the friction coeffience for macropore pipe system. It has great effect on the falling-limb of a peak flow hydrograph. 1 ~ 100
roughness Dimensionless, the Manning's roughness for watershed surface. It has great effect on the peak timing and smoothness of the hydrograph. 0.1 ~ 1.0
Manning Dimensionless, the Manning's roughness for channel segments. It has large effect on the peak timing and smoothness of the hydrograph. 0.05 ~ 0.5
SnowMelt_Df m/oC/hr, the degree-day snowmelt factor. It has great effect on the snowmelt-caused flow event, both peak and event period. 10-4 ~ 10-2

Spatial Scale

Unrestricted distributed cell geometry and size. Tested: <45 meters for the longest edge of a cell. But larger scale should be applicable as long as each

	cell is plane.
Temporal Scale	Continuous Simulation. Tested: 0.5hr, 1hr, 4hr, 12hr, 24hr. Length temporal scale will introduce timing offset to the simulation.
Input Requirements	(1) Required Data i. DEM data ii. Precipitation Data iii. Geographical Coordinators iv. Air Temperature Data v. Soil Survey Data (2) Optional Data i. Stream flow Data ii. Soil Infiltration Data iii. Macropore Pipe Data iv. Channel Geometry Data (3) System Parameter Data i. System Control Parameters 1) Unit Usage 2) Time Domain 3) Output Unit Option 4) File Name Definitions 5) Switch Parameters 6) Visualization Control ii. System Model Parameters.
Computer Requirements	(1) Hardware Minumum: 486DX2 66 with 8MB RAM and 50 MB HDD (2) Software Minumum: Windows 3.1 for Workgroup and up. Tested in Windows 95, 98 and Windows NT.
Model Output	(1) Two-Dimensional Data i. Stream Flow ii. Water Storage iii. Vertical Flux iv. Soil Moisture Content v. Temperature vi. Conductivity (2) Three-Dimensional Data i. Topographical Output ii. Stream Segment iii. Stream Network iv. Watershed Cells, Boundary and Flowpath (3) Hydrologic Output i. Flows for Stream Segments ii. Water Storage for Watershed Cells.
Parameter Estimatn Model Calibrtn	The OWLS model has default parameter set calibrated from an experimental watershed in Maine, USA. Some of the parameters have to be obtained from the field measurement. Some can be estimated from the physical equations. Others should be manually calibrated. The OWLS model provides a set of rules for manual calibration to the parameters. No automatic processing was developed at this point.
Model Testing Verification	The OWLS model has been testing to a pair of watersheds in Bear Brook Watershed of Maine. The watershed research is one the long-term project sponsored by US EPA (http://www.umaine.edu/WaterResearch/linking.html) .
Model Sensitivity	Inflitration, macropore and conductivity parameters are most sensitive factors to the OWLS model.
Model Reliabiity	(1) The model has been tested for good overall water balance. Leaking from numerical simulation has been prevanted. (2) The model was calibrated in one watershed for a period of time and validated in another watershed and the same watershed for different period of time. Results are generally accurate as compared with the real observations. (3) The model was also tested for different cell structure and different temporal scale. All tests produced consistent results for the same period of time.
Model Application	The OWLS model has been applied to simulate the dynamic hydrologic

	processes in the experimental watershed in Maine.
Documentation	The model source code, executable, technical document and user manual in MS Word format are freely available through the internet site: http://hydromodel.com
Other Comments	20. References: (1). Chen, Huaisheng. 1996. Object Watershed Link Simulation (OWLS). Ph.D. Dissertation, Oregon State University. U.S.A. (2). H.Chen and R.Beschta. 1999. Dynamic Hydrologic Simulation of the Bear Brook Watershed in Maine (BBWM). Environmental Monitoring and Accessment 55:53-96, 1999 (3). H.Chen and R.Beschta. 1999. Dynamic Hydrologic Simulation of the Bear Brook Watershed in Maine (BBWM). THE BEAR BROOK WATERSHED IN MAINE: A Paired Watershed Experiment - The First Decade (1987-1997) Edt: Stephen A.Norton and Ivan J. Fernandez. P53-96, Kluwer Acadmic Publishers, 1999.
Date of Submission	1/11/2000 9:47:49 AM
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